Federal Emergency Management Agency Building Performance Assessment Team

BPAT Update

SEPTEMBER 1999

BPAT Program Anticipates a Busy Hurricane Season

This hurricane season is likely to produce an above-average number of tropical storms and hurricanes.

The BPAT Program is expecting an active 1999 Atlantic hurricane season. Predictions from the National Oceanic and Atmospheric Administration (NOAA) and its Hurricane Research Division (HRD), the Climate Prediction Center (CPC), the National Hurricane Center (NHC), and Dr. William Gray, Professor of Atmospheric Science at Colorado State University, all indicate that this hurricane season is likely to produce an above-average number of tropical storms and hurricanes. These predictions are based in part on the indicator La Niña. La Niña is the name given to below-average sea-surface temperatures in the equatorial central and eastern regions of the Pacific Ocean. Hurricane forecasters use the presence of La Niña as an indicator of increased hurricane activity.

"Busy Hurricane Season," continued on page 6

Debris generated by a violent tornado in Moore, Oklahoma.

BPAT Process Activated for Midwest Tornadoes in Oklahoma and Kansas

In response to the tornadoes that struck Oklahoma and Kansas on May 3, 1999, the FEMA Mitigation Directorate deployed a BPAT to the area on May 10, 1999. It was estimated that 67 tornadoes were part of the May 3 outbreak and that of these, 4 were "violent" events (F4 or F5 on the Fujita Scale).

The BPAT evaluated both residential and non-residential structures and investigated issues relating to building performance during tornadoes, including windborne debris and sheltering.

The BPAT began its ground investigations in the surrounding areas of Oklahoma City, Oklahoma, including Bridge Creek, Moore, Del City, Midwest City, Stroud, and Mulhall. The team also visited the Project

"Midwest Tornado BPAT," continued on page 2

"Midwest Tornado BPAT," continued from page 1

Impact Community of Tulsa, Oklahoma. The team then performed ground investigations in Kansas beginning in unincorporated areas of Sedgwick County and continuing to nearby Haysville and Wichita.

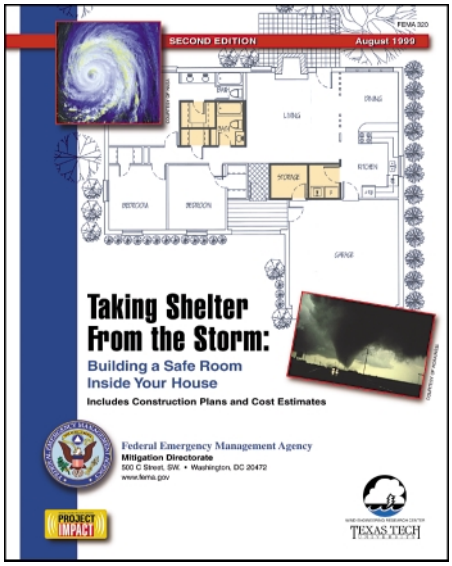
This power pole penetrated a window and extended several feet into a house. It was roughly 40 feet from the original location of the pole to the window in the photo.

Windborne Debris

The BPAT examined the affected areas to identify sources of windborne debris and to determine how this debris could be reduced during future tornadic events. Windborne debris can penetrate building envelopes and lead to further damage. When a building envelope is breached, internal pressurization increases loads that result in roof and wall failures.

The size and force of windborne debris generated by tornadoes varies in relation to tornado intensity and distance from the vortex. The most common missiles observed by BPAT members were from wood framing members. However, the team also observed higher-energy missiles including manufactured home chassis, power poles, propane tanks, steel dumpsters, steel decks and supporting joists, and trees.

Shelters



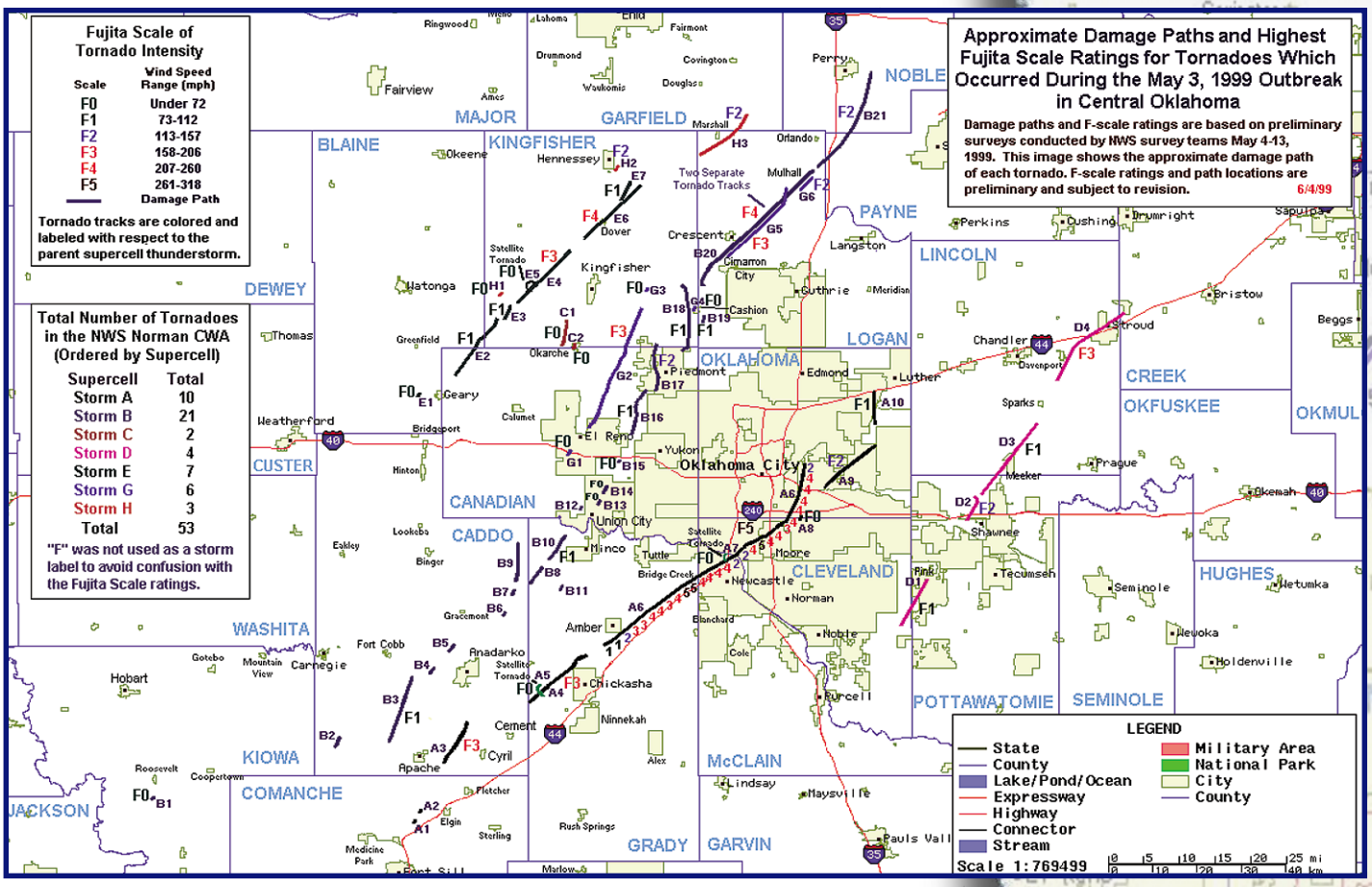
Engineered shelters provide the best protection against loss of life for people subjected to tornadoes. Both aboveground and belowground shelters were observed by the BPAT. FEMA's publication 320, *Taking Shelter From the Storm: Building a Safe Room Inside Your House*, contains design guidance and construction plans developed in part by the Wind Engineering Research Center at Texas Tech University for aboveground, belowground and basement shelters.

Oklahoma

After meeting with FEMA personnel at the Disaster Field Office (DFO) in Oklahoma City, the BPAT began its ground investigations.

Bridge Creek Area

The BPAT began its investigations in the rural suburb of Bridge Creek, southwest of Oklahoma City. The tornado caused wide-



Paths of tornadoes that struck Oklahoma on May 3, 1999.

spread, devastating damage in this area. Manufactured and single-family homes were destroyed by this tornado. Several belowground shelters and one aboveground shelter were observed in this area. The doors of several belowground shelters that were observed had failed, allowing debris to enter.

Moore

A media representative from the National Geographic Society joined BPAT members during part of their damage assessment of Moore. Moore is south of Oklahoma City and sustained some of the heaviest damage observed by the BPAT. The "violent" F4 and F5 tornadoes touched down in this area. The BPAT visited several damaged schools and assessed safe areas within the schools. One such school, Kelly Elementary School, was a steel-frame building that had been in the direct path of the vortex of the reported F5 tornado. The school had sustained severe damage. The team investigated residential building performance and noted the failure of unreinforced masonry chimneys on hip roofs. The team met with a principal of one school and evaluated the school's emergency operations plan.

Widespread door failures were observed on belowground shelters, including failures of both metal and wooden doors.

Above ground in-residence shelter.

Del City

A FEMA Public Affairs media crew joined the BPAT in documenting two storm shelters in Del City that had performed well. One was an aboveground reinforced concrete structure built as part of a renovation. The shelter survived a major tornado and supports design approaches and concepts described in the FEMA document, *Taking Shelter from the Storm*. The second shelter was a belowground structure constructed from steel forms with concrete to provide water tightness. Although the residents using the shelter had difficulty keeping the door closed, the shelter was able to provide a place of refuge.

Midwest City

BPAT members visited a mass shelter at Midwest City High School that is designed to hold approximately 2,500 people. When this shelter is needed in response to a natural hazard event, the Red Cross notifies the School District and assists in opening the facility. When a tornado struck this area during a special event, 5,000 people took refuge in the shelter. The shelter successfully protected these people. The BPAT also met with a member of the Midwest City Fire Department who briefed the team on the damage from the F5 vortex that passed through the town.

Stroud

The BPAT visited the site of an outlet mall in Stroud that had been destroyed by a tornado. The mall provided 75 percent of the town's tax base. The team also investigated damage at a hospital in the town and found extensive internal water damage that resulted from the failure of the built-up roof covering.

A portion of the Outlet Mall in Stroud, OK, destroyed by the tornado.

Mulhall

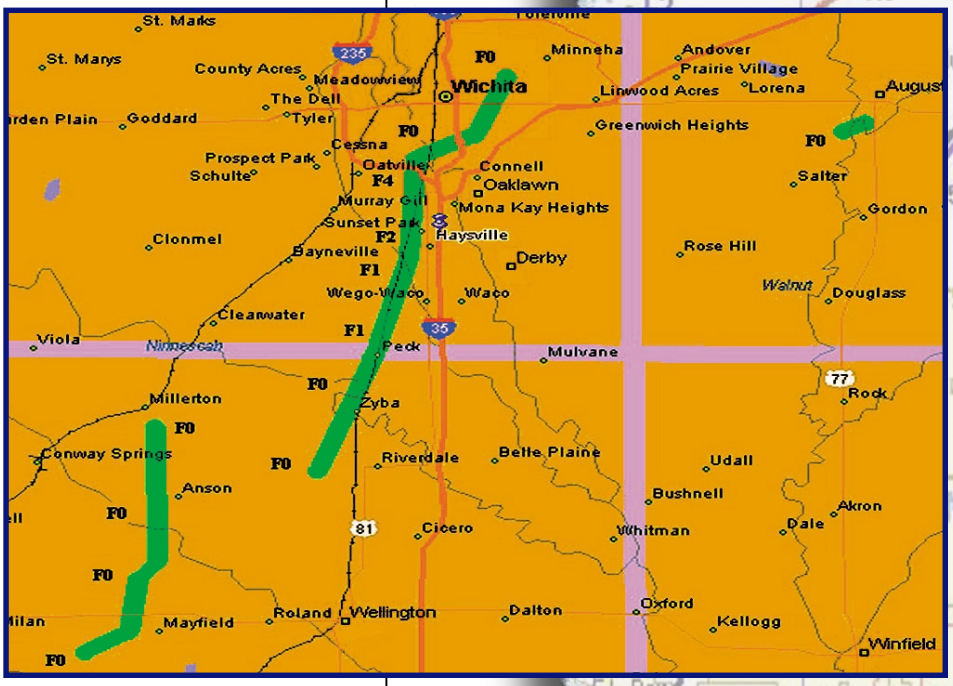
Mulhall is approximately 40 miles north of Oklahoma City. Approximately 90 percent of Mulhall was destroyed by the tornadoes. The U.S. Army Corps of Engineers had already begun clearing debris from the area when the BPAT arrived, which hindered building performance assessments. Two historic buildings on the National Register, a church and bank dating form 1894, appeared to be salvageable.

Kansas

A planning meeting between local officials and the BPAT was held in Kansas to map the BPAT's route. Additionally, local and state officials and representatives from the Disaster Field Office (DFO) joined the BPAT in some of their investigations in Kansas.

Haysville

The team visited Haysville, where the entire historic district was destroyed by the tornadoes. The team visited a plastics plant where the emergency plan was activated when a supervisor heard a tornado warning on a weather radio. A shelter inside the plant protected 64 people during the tornado. Members from the team met with the architect who designed the mass shelter for the plastics plant.



Paths of tornadoes that struck Kansas on May 3, 1999

Wichita

The local media joined the BPAT in visiting an apartment complex in Wichita that had been severely damaged by the tornadoes. The team observed a windborne missile that had penetrated an apartment building.

The team also visited a manufactured home park that had sustained heavy damage. The team noted that the damage was caused by wind pressures and missile impact, and also saw evidence of improperly installed and connected straps and anchors pulled from the soil. During the tornado, many of the residents of the park stayed in a mass shelter located at one end of the park.

The team investigated other residential neighborhoods in Wichita and observed failure of chimneys located at the end of hip roofs and progressive failure to roofs that likely began with the failure of the attached garage. Local and state officials and representatives from the DFO joined the BPAT in visiting a community of single-family patio homes that were under construction. The contractor was building interior aboveground reinforced concrete shelters as part of the homes and therefore helping to make the community disaster-resistant.

Aboveground shelters being built in a new development.

The team investigated non-residential structures in Wichita including a community center, a bread plant, and several schools. The BPAT

"Midwest Tornado BPAT," continued on page 7

"Busy Hurricane Season," continued from page 1

Current water temperatures indicate that La Niña is in effect and is expected to remain through the core months of the hurricane season, August to October. Forecasters use the combination of Pacific Ocean temperatures and several other indicators, including Atlantic Ocean temperatures and global rainfall and wind patterns, to predict hurricane activity.

Dr. Gray and co-authors write an Atlantic hurricane forecast that is posted on the Colorado State University Department of Atmospheric Science web site (**http://typhoon.atmos. colostate.edu**). The original forecast is written in November, and updated in April, June, and August. This year, the 16th year of the forecast, Dr. Gray and his co-authors predict an above-average occurrence of hurricanes and tropical storms and offer estimates of the frequency of several hurricane-related events. The forecast is based on the authors own "statistical forecast schemes and qualitative adjustments, which reflect additional effects associated with supplementary global atmospheric and oceanic information that is not yet incorporated in our statistical models." They compare these frequencies of occurrence to the annual average frequencies based on the last 40 years of hurricane data. Some of these events and related frequencies are listed below (June update).

Predicted Frequencies of Occurrence for the 1999 Atlantic Hurricane Season

Hurricane Event	1999 Predicted Frequency	Annual Average Frequency
Named Storms*	14	9.3
Hurricanes	9	5.8
Intense Hurricanes**	4	2.2

*A hurricane or tropical storm.

**A hurricane with a Category 3 or greater rating on the Saffir/Simpson Scale, which is given to hurricanes that sustain a 111-mph or greater low-level wind.

Dr. Gray and his associates have also produced probability estimates of an intense hurricane making landfall over various areas for the 1999 hurricane season. These are compared to annual average probabilities that are based on data from the last 100 years. These estimates are listed below (June update).

1999 Atlantic Hurricane Landfall Probabilities (%)

Hurricane Event	1999 Predicted Probability	Annual Average Probability
The Entire Eastern U.S. Coastline from Brownsville, TX to Canada	72	50
The U.S. East Coast, including the Florida Peninsula	54	31
The Gulf Coast from the Florida Panhandle to Brownsville, TX	40	30
The Caribbean and Bahamas	72	51
The East Coast of Mexico	28	18

"Busy Hurricane Season," continued on page 7

"Busy Hurricane Season," continued from page 6

The Atlantic hurricane season is from June 1 through November 30, but the height of hurricane season is considered August to mid-October. Potential BPAT members should be aware of hurricane activity. If a BPAT is to be deployed, the BPAT contractor will contact team members to authorize them to travel to the specified destination a designated time. FEMA is developing a BPAT Pre-deployment Package that will address some of the most frequently asked questions about BPAT field work and preparedness. Look for the package to be posted on the BPAT web site within the next 1-2 months (**www.fema.gov/mit/bpat/**).

FEMA Needs Dam Engineers to Join the BPAT Program

FEMA is currently looking for experienced dam engineers to supplement the BPAT database. Professional engineers who have knowledge of dam design, operation, safety requirements and breach conditions are needed for potential post-disaster operations. Dam engineers would be asked to participate on a BPAT if a dam breaks, is overtopped, or if major water released causes significant property damage or loss of life after a natural disaster.

Registered engineers who have expertise in this field who wish be part of the BPAT program should fill out the form and mail to the stated address or fill out the on-line form at the BPAT website at **www.fema.gov/mit/bpat**.

"Midwest Tornado BPAT," continued from page 5

noted that the community center did not have an adequate mass shelter area and that one of the schools had lost part of its roof leaving the interior vulnerable to wind, windborne debris, and rain damage.

The preliminary BPAT report will be submitted in early July and will be available over the Internet at **http://www.fema.gov/mit/bpat/midtorn/index.htm**

The Fujita Scale

F0 Light: Chimneys are damaged, tree branches are broken, shallow-rooted trees are toppled.

F1 Moderate: Roof surfaces are peeled off, windows are broken, some tree trunks are snapped, unanchored mobile homes are overturned, attached garages may be destroyed.

F2 Considerable: Roof structures are damaged, mobile homes are destroyed, debris becomes airborne (missiles are generated), large trees are snapped or uprooted.

F3 Severe: Roofs and some walls are torn from structures, some small buildings are destroyed, non-reinforced masonry buildings are destroyed, most trees in forest are uprooted.

F4 Devastating: Well-constructed houses are destroyed, some structures are lifted from foundations and blown some distance, cars are blown some distance, large debris becomes airborne.

F5 Incredible: Strong frame houses are lifted from foundations, reinforced concrete structures are damaged, automobile-sized missiles become airborne, trees are completely debarked.

YOU Can Become Part of the BPAT Program

Experts are Needed in the Following Fields:

- Structural and Civil Engineering
- Building Design and Construction
- Coastal Construction
- Flood-, Wind-, and Earthquake-Resistant Design and Construction
- Shoreline and Coastal Erosion
- Building Inspection
- Building Code Development and Enforcement

Are you interested in serving on FEMA Building Performance Assessment Teams or supporting other hazard mitigation activities carried out by FEMA? If you are an expert in one of the fields listed above and can be available for temporary field assignments on short notice, please let us know.
Fill out the form below and return it by mail to:

Greenhorne & O'Mara, Inc.
9001 Edmonston Road
Greenbelt, MD 20770
Attn: Eric Letvin, or you may fax your information to (301) 220-2595.

Name: _____

Expertise: _____

Company/Affiliation: _____

Street Address: _____

City: _____ State: _____ Zip: _____

Phone: ( ) _____ Fax: ( ) _____

Federal Emergency Management Agency
500 C St. SW.
Washington, DC 20472
MT-AO Room 411